MedCrave
Step into the World of Research

Journal of Neurology & Stroke

Research Article

Open Access
CrossMark

Brachial plexus surgery: clinical analysis of ten cases

Abstract

Background and Aim: Brachial plexus surgery is a complex surgery and multiple surgical techniques were advanced. The concept that patients who underwent surgery will obtain full recovery is still far from the truth. In this study, we show our results after usage some surgical techniques, aiming to describe them.

Methods: Through case series study, the team operated 10 cases, including infants and adults (Seven males and three females) between January 2013 and June 2015. Detailed history, physical examinations, radiological imaging studies and electrophysiological studies were performed to confirm the nature and severity of the injury. Exclusion criteria, including individuals who spontaneously recovered after 4 months or those came after more than 12 months of injury. Neurolysis, nerve grafting and nerve transfer were done according to certain protocol performed for each case.

Results: History of road traffic accident was reported in five cases, obstetric brachial plexus palsy in three cases, gunshot wound in two cases. They were diagnosed as upper brachial plexus injury (4 cases), lower brachial plexus injury (2 cases), and complete flail limb (4 cases). Four cases were submitted into neurolysis, three into nerve grafting, and three into the nerve transfer . Four cases showing functional motor outcome improvement (2 cases, Neurolysis and 2 cases, nerve transfer) but the other six cases do not show any improvement until now (3 nerve grafting, 2 neurolysis and 1 nerve transfer) . Assessment of the motor power was done using the Medical Research Council scale. One case was complicated immediately post-operatively with pan plexopathy of the same limb of surgery and was improved one week after.

Conclusion: Brachial plexus surgery renders satisfactory results for restoring the upper limb functions. The results shown that neurolysis and nerve transfer give better results than nerve grafting.

Keywords: Brachial plexus injury, Obstetric brachial plexus injury, Flail limb, Nerve transfer, Neurolysis

Volume 4 Issue 4 - 2016

Ali Abou-Madawi,[1] Ayman E Galhom,[2] Mohamed Elqazaz,[1] Essam A Elkhatib,[1] Tariq Emam Elshafaey,[1] Mohamed A Ellabban,[3] Wael M Elkholy,[4] Mohamed Elsebaey Elsayed[4]

[1]Department of Neurosurgery, Suez Canal University, Egypt
[2]Department of Neurosurgery, Portsaid University, Egypt
[3]Department of Plastic Surgery, Suez Canal University, Egypt
[4]Department of Neurosurgery, Damanhor Medical National Institute, Egypt

Correspondence: Mohamed Elsebaey Elsayed, Department of Neurosurgery, Damanhor Medical National Institute, Damanhor, Egypt, Email seba3y700025@yahoo.com

Received: January 07, 2016 | **Published:** March 29, 2016

Introduction

Brachial plexus injuries comprise about one-third of all peripheral nerve injuries and seen in just more than 1% of patients presenting to a trauma facility. Males are affected more than females with a median age of 34-year-old because of the association of such injuries with violent trauma and contact sports. 80% of patients with severe traumatic brachial plexopathy had multiple traumas to the head and skeletal system and may result in profound functional impairment of the upper extremity. Brachial plexus injury may range from weakness or paralysis of the shoulder and/or elbow to complete paralysis and loss of feeling in the entire upper limb. Over the last two decades, refinements in microsurgical techniques, and significant advances in the concepts of peripheral nerve repair and reconstruction have greatly expanded treatment options for these otherwise devastating injuries.[1-5]

Aim

The team published this study to describe his experience in dealing with the brachial plexus injuries aiming to help in decision making among these injuries through choosing the proper surgical technique.

Material and methods

Ten patients were treated for traumatic brachial plexus injury at the Department of Neurosurgery, Suez Canal University and Department of Neurosurgery, Damanhur Medical National Institute between January 2013 and June 2015. (Table 1) A detailed history was obtained and through physical examinations and radiological studies of the neck, shoulders, and chest were performed to confirm the nature and severity of the injury. Magnetic resonance imaging, Computerized tomography myelogram electromyography, and nerve conduction studies were used in the precise diagnosis.

The proper plan was put to each patient according to the deficits taking in mind that the aim of management is obtaining the maximal motor function of the shoulder, elbow, and wrist plus management of the severe intolerable pain if found. Individuals who spontaneously recovered after 4 months of conservative treatment and physiotherapy after incomplete injuries and who came after more than 12 months of injury were avoided from this study. Surgical intervention was done for cases that follow the optimum conservative measures and do not show any signs of recovery clinically nor by electromyographical studies.

Intraoperative Nerve Stimulator was used. Neurolysis, neurorrhaphy, nerve grafting and nerve transfer were done according to the clinical assessment and the radiological and electrophysiological studies and certain protocol was performed for each case according to the deficits and needs. Patients were clinically evaluated before and after surgery using the medical research council (MRC) grades as follows: excellent, G5; good, G3-4; fair, G2; and poor, G0-G1. Recovery after surgical intervention is considered starting from G3 or higher.

Surgical technique

Under general anesthesia without muscle relaxants, patients were placed in supine position with head tilted to the healthy side. (Figure 1) Cotton bags were put interscapular and under the neck, making the affected side more prominent. The affecting upper limb was put abducted on board. Preparing and draping the neck, the upper limb and both legs for probability of sural nerve harvesting. Skin incision was beginning at the posterior border of the sternomastoid muscle upward downwards, then curving laterally parallel to the clavicle, two finger breadth, then crossing the deltopectoral groove to the axillary crease.

Figure 1 Marking of the skin incision in the anterior infraclavicular approach.

The supraclavicular approach allows exposing the spinal roots, trunks, suprascapular nerve, spinal accessory nerve and phrenic nerves, ligation of the external jugular vein, skeletonizing the scalene anterior and scalene medius muscle and dividing the omohyoid muscle. Tracing the phrenic nerve cautiously upwards into the C5 and C6 roots, then identifying the upper trunk.

The Infraclavicular approach allows exposing the divisions, cords and terminal branches, especially after dividing the pectoralis minor muscle. Identifying the lateral cord, musculocutaneous nerve, posterior cord, radial nerve, medial and lateral contribution of the median nerve (M-shape) becoming accessible especially after ensuring their anatomical structures by the nerve stimulator.

The posterior approach was also used in the innervation of the axillary nerve, the skin incision used parallels the posterior border of the affected deltoid muscle (Figure 2).

The incision is deepened, taking care to preserve the cutaneous sensory branch of the axillary nerve. This is then followed down to the quadrangular space after reflecting the deltoid muscle anteriorly. At this point, the main stem of the axillary nerve as well as its divisions (anterior and posterior) are identified. The anterior division is specifically dissected out from the adjacent soft tissue and is traced back into the main stem to gain as much length as possible. The axillary nerve is then transected deeply and clipped to a green background for future identification. Leave the posterior division of the axillary nerve intact, should spontaneous recovery ensue. The radial nerve and its branches to the triceps are now identified in the triangular space. The interval between the long and lateral heads of the triceps is opened, and the radial nerve is readily exposed. Several triceps branches are identified, tagged with vessel loops and tested for function using a nerve stimulator. The longest, largest functioning motor radial branch to any of the triceps heads is identified (often the branch of the medial head). Other branches to the triceps and the main radial nerve are protected.

Figure 2 Marking of the skin in the posterior approach, notice the deltoid muscle (Suez Canal University Hospital, Ismailia, Egypt).

The selected triceps branch is then traced distally to gain as much length as feasible. It is also traced proximally and separated from the main radial nerve so as to displace the pivot point closer towards the deltoid muscle.

This permits not only adequate length to perform a direct graft-free nerve transfer, but also provides a little extra length. The surgeon can trim the recipient nerve back closer to the motor point of the deltoid to enable faster and perhaps better muscle reinnervation. The suture line is later rechecked with the arm in a position of abduction and external rotation before final approximation.

If the anatomical structures are in continuity and the NAP is present, just external neurolysis was done. If there is an obvious anatomical defect, nerve grafting was done. If there is a neuroma, NAP decides if there is a function in continuity or not and according to the aim of the surgery in the protocol of these cases, resection, nerve grafting or nerve transfer was done. Avoiding tension and doing microscopic suturing ensure an optimum chance for good repair and regeneration. Sural nerve was used when grafting was needed.

The spinal accessory nerve (distal branches) was used when neurotization of the suprascapular nerve was needed; intercostal nerves (3rd, 4th and 5th) were used when neurotization of musculocutaneous nerve was needed (Figure 3).

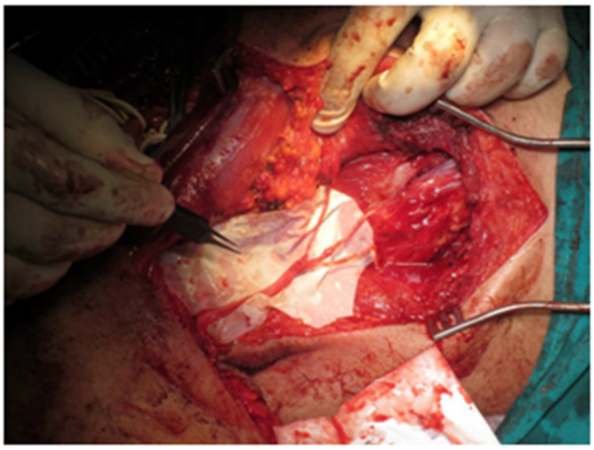

Figure 3 Intraoperative picture showing musclucutanous nerve neurotization by three intercostal nerves. (Suez Canal University Hospital, Ismailia, Egypt).

Results

Patient population

The series contains 10 cases, 7 males and 3 females, aged from 7 months to 30 years (mean 15.8 years). Five were injured in road traffic accidents mainly motorcycle accidents; two were injured in gunshot wound while three were birth related brachial plexus injury.

Mechanism of injury and type of brachial plexus injury

The types of brachial plexus injury were as follows: velocity injury in 2 patients, compression injury in 1 patient and stretch avulsion injury in 7 patients. Four patients presented with upper brachial plexus injury, two patients presented with lower brachial plexus injury and four patients presented with the total flail limb.

Associated injuries

One patient had associated vascular injury (axillary artery injury) and fracture humerus after the gunshot. One patient had fracture clavicle after RTA. One patient had fractured ribs and pneumothorax in the same side of the affected limb.

Treatment and outcome

Neurolysis technique: Four patients underwent external neurolysis, two of them (case 1 and 7) gained useful recovery MRC grade 4.

Nerve grafting technique: Three patients underwent nerve grafting as follows: in case 2 and 10, neuroma was found in the lateral cord, resection, and grafting using sural nerve was done. (Figure 4 & 5) In case 6, neuroma was found in the lateral cord and ulnar nerve, resection and grafting was done using the sural nerve.

Nerve transfer technique: Three patients underwent nerve transfer as follows: in case 4, distal branches of the spinal accessory nerve (SAN) were transferred to the suprascapular nerve (SSN), and Musculocutaneous nerve (MCN) also neurotized by the 3rd, 4th and 5th intercostal nerves. In cases 5 and 9, the posterior approach was applied and the axillary nerve was neurotized by the medial branch of the radial nerve and gained useful motor recovery.

All the cases underwent the surgery without gaining any superadded deficits except in case 9, the patient immediately complains of pan plexopathy that resolved in the following week, that claimed by the surgical team to the hard band which was under the shoulder along the all-time of surgery. All the cases underwent physiotherapy and rehabilitation programs before the surgical intervention till it was ensured that no further improvement was suspected from further physiotherapy without the surgical intervention. Also, after about 4 weeks post-operative, the patient was instructed to continue the physiotherapy for years and the regular follow- up visits to determine the progress and feedback of the rehabilitation programs.

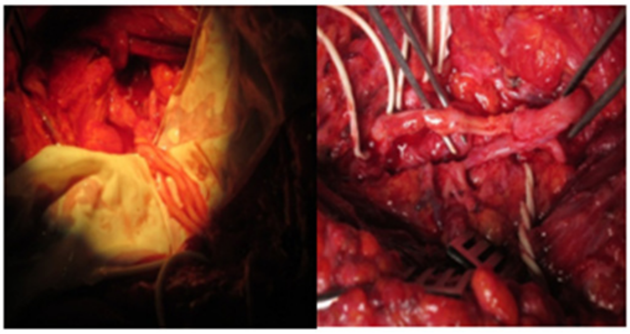

Figure 4&5 Intraoperative pictures showing the sural nerve while being cabled and used in grafting (Suez Canal University Hospital, Ismailia, Egypt).

Discussion

In this study, we summarize our results of management of ten cases of brachial plexus injuries with different types and mechanisms of injury by techniques of neurolysis, nerve grafting and nerve transfer through different approaches (Table 2).

The optimal time for surgical reconstruction has been debated over the years with a move towards early intervention. Timing is a balance between the improvements that can occur with conservative treatment and the development of irreversible muscle atrophy that occurs with denervation. The proper rehabilitation program and compliance of the patients is also a cornerstone in the protocol of management.[6]

rachial plexus injuries have numerous causes include;

1. Traction (stretch) injuries are resulting from forceful downward displacement of the shoulder or arm, often with lateral flexion of the neck in the opposite direction. Also the improper positioning in the operating rooms during Cardiothoracic and neurosurgery especially in prone position.[7-9]
2. Penetrating trauma to the neck or the shoulder may result in contusion or disruption of the brachial plexus. Major vascular injuries may be associated due to the proximity of the subclavian vessels and external jugular vein.[10]
3. Birth-related paralysis is often associated with high-weight babies and with shoulder dystocia. Less common causes include blunt trauma around the shoulder girdle, compressive lesions, radiation and neoplasms.[11]

The most common clinical syndromes of brachial plexus injuries may be divided into supraclavicular and infraclavicular lesions.[1,12]

Supraclavicular lesions involve injury at the level of the roots and trunks

(1) Total plexus lesions result from loss of function of all the five roots or all the three trunks.

(2) Upper plexus lesions (Erb's Palsy) result from loss of function of the C5 and 6 roots or upper trunk.

Citation: Abou-Madawi A, Galhom AE, Elqazaz M, et al. Brachial plexus surgery: clinical analysis of ten cases. *J Neurol Stroke.* 2016;4(4):1–6.
DOI: 10.15406/jnsk.2016.04.00139

(3) Upper and middle plexus lesions result from loss of function of the C5, C6 and C7 roots or upper and middle trunks.

(4) Lower plexus lesions (Klumpke's Palsy) as an isolated clinical syndrome is rare and results from injury to the C8 and T1 nerve root or lower trunk.[12]

Infraclavicular lesions involve the cords of the brachial plexus or the proximal portions of the major peripheral nerves of the upper limb.

1) Total plexus injury results from injury to the lateral, posterior and medial cords.
2) (2) Posterior cord injury is probably the most common infraclavicular syndrome and results in weakness of shoulder abduction and loss of elbow, wrist and finger extension.
3) (3) Lateral cord injury results in absent or weak elbow and wrist flexion and to a variable degree weakness of thumb and finger flexion.
4) (4) Medial cord injury presents a similar clinical picture of the patients with a lower brachial plexus injury. There will be paralysis of the intrinsic muscles of the hand, some degree of weakness of the finger flexors and impaired feeling in the small, ring finger and the medial aspect of the forearm.[12]

The appropriate treatment of brachial plexus injuries must be individualized depends primarily on whether the nerves are disrupted or not, as well as the duration post-injury.[13] The use of the support splints or a sling is potential for recovery of function in stretch injuries that not associated with acute nerve disruption. The surgical intervention may be indicated if there is little evidence of progressive spontaneous recovery of motor and sensory function by three months following injury, but no longer than 6 months.[2,3] However, early surgical exploration is frequently indicated in penetrating or open injuries.[14] As the vast majority of brachial plexus injuries are closed, the diagnosis of nerve disruption as opposed to a stretch injury to an intact nerve may be difficult. The presence or absence of recovery is based on serial clinical examinations over the first three months post injury as well as some diagnostic tests; nerve conduction, and electromyography studies. Magnetic resonance imaging (MRI) of the brachial plexus and cervical spine, and myelography with computerized tomography (CT), are the key of the final differentiation.[15]

Surgical management includes the following lines that subdivided into many variants according to the current status of each case:

Neurolysis

This involves thorough exploration and dissection of the plexus elements in a circumferential, 360-degree fashion.[14,4]

Nerve repair and nerve grafting

Nerve repair is indicated for the treatment of open wounds with clean transection of a part of the plexus, if the proximal and distal stumps can be clearly identified. Nerve grafting is indicated in cases of loss of continuity, either caused by sharp or traction injury at the level of the spinal nerve trunks, or by cords or lesions in continuity.[16,17]

Neurotization (Nerve Transfer)

Neurotization involves the transfer of a normal nerve with an unimportant function to the site of a permanently damaged nerve with more important functions. Available donor nerves for neuroneural neurotization: spinal accessory nerve, phrenic nerve, intercostal nerves,[18] fascicles of ulnar nerve, fascicles of the median nerve and others.[19]

In the brachial plexus paralysis, the most important function is elbow flexion,[20] and thus renervation of the musculocutaneous nerve has the highest priority.[4,18,21] The restoration of shoulder control comes next, and therefore the suprascapular and axillary nerves are next on the renervation list, especially the posterior approach that used in this series and the results are excellent,[22,23] to be followed by re-innervations of the median nerve to restore digital sensibility and forearm flexor function, and the radial nerve for elbow extensor,[24] wrist extensor and finger extensors.[25,26] Muscles innervated by the ulnar nerve are last on the priority list, not because they are unimportant, but because the chance of recovery of intrinsic muscle functions is minimal.

Conclusion

Factors like the age of the patient, duration and mode of injury determine the goals of the management and the role of surgery. Various techniques and approaches are present, but selection the proper plan is the challenge for the brachial plexus surgeon who must take in mind the intraoperative findings and dealing with them. It is believed that surgical outcome can be improved if the optimal repair procedure is selected. The results shown that neurolysis and nerve transfer give better results than nerve grafting.

Acknowledgments

None.

Conflicts of interest

None.

References

1. Bertelli JA, Ghizoni MF. C5–8 brachial plexus root injury: The "T–1 hand". *J Neurosurg*. 2012;116(2):409–413.
2. Bertelli JA, Ghizoni MF. Results and current approach for brachial plexus reconstruction. *J Brachial Plex Peripher Nerve Inj*. 2004;6(1):2.
3. Bhandari PS, Bhatoe HS. Timing for repair in brachial plexus injury. *Ind J Neurotrauma*. 2012;9(2):85–86.
4. Brophy RH, Wolfe SW. Planning brachial plexus surgery: Treatment options and priorities. *Hand clinics*. 2005;21(1):47–54.
5. Kim DH, Cho YJ, Tiel RL, et al. Outcomes of surgery in 1019 brachial plexus lesions treated at Louisiana State University Health Sciences Center. *J Neurosurg*. 2003;98(5):1005–1016.
6. Nudo RJ, Plautz EJ, Frost SB. Role of adaptive plasticity in recovery of function after damage to motor cortex. *Muscle Nerve*. 2011;24(8):1000–1019.
7. Brunette KE, Hutchinson DO, Ismail H. Bilateral brachial plexopathy following laparoscopic bariatric surgery. *Anaesth Intensive Care*. 2005;33(6):812– 815.
8. Goettler CE, Pryor JP, Reilly PM. *Brachial plexopathy after prone positioning*, critical care. 2002;6(6):540–542.
9. Ngamprasertwong P, Phupong V, Uerpairojkit K. Brachial plexus injury related to improper positioning during general anesthesia. *J Anesth*. 2004;18(2):132–134.
10. Kim DH, Murovic JA, Tiel RL, et al. Penetrating injuries due to gunshot wounds involving the brachial plexus. *Neurosurg Focus*. 2004;16(5):E3.
11. Kim DH, Murovic JA, Tiel RL, et al. Mechanisms of injury in operative brachial plexus lesions. *Neurosurg Focus*. 2004;16(5):E2.
12. Bertelli JA, Ghizoni MF. Reconstruction of C5 and C6 brachial plexus avulsion injury by multiple nerve transfers: spinal accessory to suprascapular, ulnar fascicles to biceps branch, and triceps long or lateral head branch to axillary nerve. *J Hand Surg*. 2004;29(1):131–139.

DOI: 10.15406/jnsk.2016.04.00139

13. Jivan S, Kumar N, Wiberg M, et al. The influence of pre–surgical delay on functional outcome after reconstruction of brachial plexus injuries. *J Plast Reconstr Aesthet Surg*. 2009;62(4):472–479.
14. Bhandari PS, Sadhotra LP, Bhargava P. Management of missile injuries of the brachial plexus. *Ind J Neurotrauma*. 2006;3(1):49–54.
15. Kline DG. Timing for brachial plexus injury: A personal experience. *Neurosurg Clin*. 2009;20(1):24–26.
16. Bertelli JA, Ghizoni MF. Results of grafting the anterior and posterior divisions of the upper trunk in complete palsies of the brachial plexus. *J Hand Surg*. 2008;33(9):1529–1540.
17. Garg R, Merrell GA, Hillstrom HJ, et al. Comparison of nerve transfers and nerve grafting for traumatic upper plexus palsy: a systematic review and analysis. *J Bone Joint Surg Am*. 2011;93(9):819–829.
18. Kakinoki R, Ikeguchi R, Dunkan SF, et al. Comparison between partial ulnar and intercostal nerve transfers for reconstructing elbow flexion in patients with upper brachial plexus injuries. *J Brachial Plex Peripher Nerve Inj*. 2010;5(1):4.
19. Chuang DC. Nerve transfers in adult brachial plexus injuries: My methods. *Hand Clin*. 2005;21(1):71–82.
20. Ferraresi S, Garozzo D, Buffatti P. Reinnervation of the biceps in C5–7 brachial plexus avulsion injuries: results after distal bypass surgery. *Neurosurg Focus*. 2004;16(5):E6.
21. Bhandari PS, Sadhotra LP, Bhargava P. Microsurgical reconstruction devastating brachial plexus injuries. *Ind J Neurotrauma*. 2005;2(1):35–39.
22. Leechavengvongs S, Witoonchart K, Uerpairojkit C,et al. Nerve transfer to deltoid muscle using the nerve to the long head of the triceps, part II: a report of 7 cases. *J Hand Surg*. 2003;28(4):633–638.
23. Malessy MJ, de Ruiter GC, de Boer KS, et al. Evaluation of suprascapular nerve neurotization after nerve graft or transfer in the treatment of brachial plexus traction lesions. *J Neurosurg*. 2004;101(3):377–389.
24. Goubier JN, Teboul F. Transfer of the intercostal nerves to the nerve of the long head of the triceps to recover elbow extension in brachial plexus palsy. *Tech Hand Up Extrem Surg*. 2007;11(2):139–141.
25. Brown JM, Yee A, Mackinnom SE. Distal median to ulnar nerve transfer to restore ulnar motor and sensory function within the hand: technical nuances. *Neurosurgery*. 2009;65(5):966–978.
26. Flores LP. Distal anterior interosseous nerve transfer to the deep ulnar nerve and end–to–side suture of the superficial ulnar nerve to the third common palmar digital nerve for treatment of high ulnar nerve injuries: experience in five cases. *Arq Neuropsiquiatr*. 2011;69(3):519–524.